deposited in this way. Thus wide sheets of boulder-clay and the "end-moraines" of a great ice-sheet have had the same origin—they consist of ground-moraine accumulated under the thinner peripheral portions of the ice.

According to the author there is no doubt that the action of the ice favours the formation of rock-basins. Should a depression or hollow occur underneath an ice-sheet, and the ice be thicker in the hollow than over the adjacent tracts, the hollow will tend to be progressively excavated. He thinks, however, that the erosive work of the ice will tend rather to the lengthening of the hollow in the direction of glacial movement than to its deepening. Wherever the ice is thickest there erosion will be most pronounced, no matter what the form of the land-surface may be. Thus rock-basins may be hollowed out even in relatively flat land, as for example, by a glacier upon the low ground opposite the mouth of a mountain valley.

Such are a few of the many interesting points connected with glacial action which are discussed by Dr. Drygalski. He concludes his work by some very suggestive remarks on the wonderful resemblances that obtain between the old gneiss-formation and the "inland ice"—the oldest and the youngest *Erstarrungsprodukte* of the earth's crust. When he had surveyed the steep gneiss-walls of the fiords, with their folded, contorted and confused bedding, their bands of crystalline schist, their veins and dykes, their fissures and fractures, he was astonished to encounter the same appearances in the "inland ice," and he follows the analogy into minute details of structure. But enough has been said to show that Dr. Drygalski's monograph is of no ordinary interest to geologists.

The chief object of the expedition being the study of ice in general and of the movement of the "inland ice" in particular, the opportunities for biological investigation did not at first appear to be very promising to Dr. Vanhöffen. But in this he was happily disappointed, for he succeeded in bringing home much material for study. His contribution to the work before us occupies the greater portion of the second volume. In this he does not confine himself to a mere description of his own investigations and their results, but gives us an exhaustive account of the fauna and flora of Greenland, including of course the life of the adjacent seas. For the benefit of those who are not specialists he illustrates his work with a number of beautiful coloured plates of some of the crustaceans, pteropods and jelly-fish which swarm in the waters of the far north. A copious bibliography is appended—great pains, indeed, have been taken to give a complete survey of the natural history of Greenland. A more special and detailed account of his own investigations is to appear in the *Bibliotheca Zoologica* and *Bibliotheca Botanica* (Stuttgart).

The concluding part of the second volume is devoted to the discussion of the magnetic, meteorological, astronomical and geodetic work of the expedition by Drs. Stade, Drygalski, and Schumann. Dr. Stade devotes a chapter to the föhn winds of West Greenland, which have long puzzled navigators and excited the superstitious fears of the Eskimo. Coming as these warm winds generally do from the ice-covered land, especially in the coldest time of the year, they seem hard to account for. According to Dr. Stade they owe their origin to depressions passing through Davis Strait from south to north. The approach of a depression is marked by strong to stormy winds from the south-east or east, the temperature of the atmosphere suddenly rising, while at the same time its relative humidity is reduced.

Altogether this most recent of Arctic expeditions has been fruitful in results, and the Geographical Society of Berlin must be congratulated on the great success which has attended the enterprise. JAMES GEIKIE.

THE PRODUCTION AND USES OF OZONE.

THOUGH it has been known for more than a century that air and oxygen acquire a peculiar odour when exposed to the action of electric sparks, and though Schönbein ascertained nearly half a century ago that this odour is due to a distinct form of matter, now called ozone, which is produced by the electrolysis of dilute sulphuric acid, by the action of electric discharge in air, and as a product of the slow oxidation of phosphorus, chemists are still trying to learn the exact conditions of the formation of this substance, and still investigating some of its simplest reactions; whilst inventors are but beginning the work of making it useful to man.

But if the wheels of science grind slowly, in the end they grind true, and various facts now distinctly suggest that ere long ozone will play a useful part in the service of medicine, of surgery, and in the arts.

Ozone has never yet been obtained as a gas in the pure state, but from the properties of mixtures containing it we cannot doubt that gaseous ozone would be blue in colour, and condense at low temperatures to an indigo-blue liquid, which explodes violently on contact with olefiant gas. The ozone in mixtures, such as are produced by the electrification of air or oxygen, is very instable, being resolved into common oxygen with explosive violence if suddenly compressed without previous cooling; and even under atmospheric pressure it cannot long be preserved except at rather low temperatures. This characteristic instability of ozone is at once the cause of its most interesting properties and of its possible usefulness. Molecules of common oxygen contain but two atoms of the element, whilst the molecules of ozone contain three such atoms, and it would seem that the atoms hold together much less firmly in the larger molecules than when they are united in pairs; consequently ozone acts as a powerful oxidiser, readily giving up part of its oxygen to oxidisable substances, whilst the rest returns to the ordinary form of the element, except in certain cases when it is completely absorbed.

Now chemists have, it is true, plenty of powerful oxidisers at their command, and many of them are inexpensive; but not even hydrogen peroxide, which can now be obtained comparatively cheaply, is quite so simple in its action as ozone, for this substance, which consists, as we have seen, of oxygen and of oxygen alone, when used as an oxidiser does not leave any inconvenient residue, such as accompany the action of many other oxidising agents. Hence a field for the employment of ozone may be found whenever a simple oxidising agent is required. Thus, for example, it has been suggested that it might conveniently be used for bleaching beeswax, starch or bones, in the manufacture of *dégras* for leather makers, in preparing drying oils for the manufacturers of varnishes, or again, according to Wiedermann, to hasten the ageing of whiskey.

There are, however, as might be expected, difficulties to be surmounted. Sometimes, as in its action as a bleaching agent, ozone is apt to act too slowly; whilst at others it is difficult to adjust the proper dose of the oxidiser. Thus we are told that port wine treated with ozone forms a deposit which quickly increases, so that the wine soon puts on an appearance which, under ordinary circumstances, it would only acquire in the course of years. But, alas! wine thus rapidly ripened is apt to fade with corresponding rapidity, owing, it is presumed, to the use of too much ozone, and hence, in the absence of any obvious method of estimating the proper dose, ozone does not yet recommend itself to wine makers or wine merchants. It has occurred to the writer, however, that it might possibly be made useful, even at the present stage, in judging unripened wine, since its use might enable the vintner to ascertain without delay how the wine of a given vintage will ultimately turn out. Unfortunately the experiment has not yet been tried, owing to the difficulty of finding a suitable colleague.

At a recent discussion on ozone at a meeting of the Society of Chemical Industry, the general opinion seemed to be that whilst there are, doubtless, possibilities of usefulness for ozone, nothing has yet been done which is likely to induce manufacturers to invest much capital in plant for its production; it is therefore interesting to learn that successful attempts have already been made to employ this interesting substance in medicine. It has long been known that ozonised air acts as a preservative of flesh, preventing and arresting putrefaction; and the simplicity of its mode of action, already alluded to, has naturally suggested its great suitability for use as an oxidiser and antiseptic in medical practice. Therefore one hears, without surprise, from those who have tried it, that in ozone we have an agent which is likely to be of real value in the treatment of diseases which are associated with the existence of organisms, or where the use of an oxidiser is indicated; for example, in the treatment of phthisis, of unhealthy wounds, and of some cases of anæmia, and for purifying the air of dwelling rooms, hospitals and public buildings.

But before ozone can play a really important part in the above or other directions, the earlier modes of making it must be improved upon, and its production cheapened.

Ozone, as has already been said, was first noticed in air which had been exposed to the sparks of electrical machines; but only very small quantities can be obtained in this way, and it is better to expose the air to a sort of electric rain composed of showers of very fine sparks, such as were employed by Andrews, or to the so-called silent discharge in one of the various forms of the "Siemens' induction tube." This in its simplest form consists of a long thin test-tube sealed at its open end into a slightly larger tube, the latter being provided with a narrow tube at each end, so that a current of gas may be passed between the two test-tubes. If the inner tube of such an apparatus be filled with dilute sulphuric acid and connected with one of the electrodes of an electrical machine, and if the outer tube be plunged in a bath of dilute acid which is connected with the other electrode of the machine, whilst air or oxygen is passed through the apparatus, a glow or a shower of fine sparks will act on the gas, and charge it more or less strongly with ozone ere it escapes.

Ozonisers such as the above have been employed in many of the chief researches on ozone, and probably give the best results when small or moderate volumes of oxygen are to be dealt with, but for work on the large scale this form of ozoniser does not give equal satisfaction. For such work it has been proposed to replace the glass tubes by sheets of glass coated with tinfoil or silvered; whilst recently a new departure has been made by Mr. Andreoli, who replaces one of the plane or curved electrodes by a conductor carrying numerous points. For manufacturing purposes Mr. Andreoli recommends the use of serrated grids made of aluminium, and carrying as many as 17,760 points on every grid. Each grid is placed opposite a sheet of aluminium with a sheet of glass interposed, the whole being bound together by wooden clamps (see Fig. 1). It is claimed that with such an arrangement of suitable dimensions, 10 kilos. of ozone can be produced at the small cost of thirteen shillings and fourpence. As the air and apparatus employed are not cooled, the charges of ozone are probably not very strong, but for many purposes this does not seem to be a matter of great importance. A more serious objection to the system lies in the fact that the employment of metallic point bearing grids seems not unlikely to favour the production of comparatively large sparks which, if they should occur, would undoubtedly cause the formation of

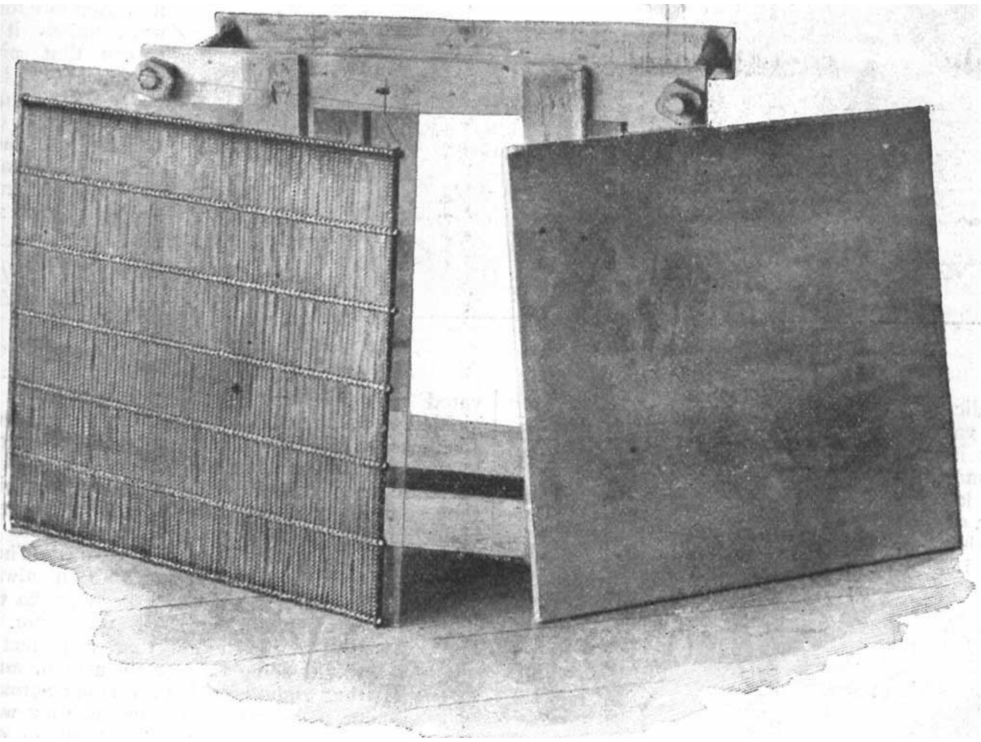

FIG. 1.

nitric peroxide. Now this gas, besides often being objectionable on its own account, would undoubtedly tend to reduce the yield of ozone. Mr. Andreoli does not, however, admit that nitric peroxide is formed in his apparatus, and if further experience should support his contention it would seem that he has really effected a substantial improvement.

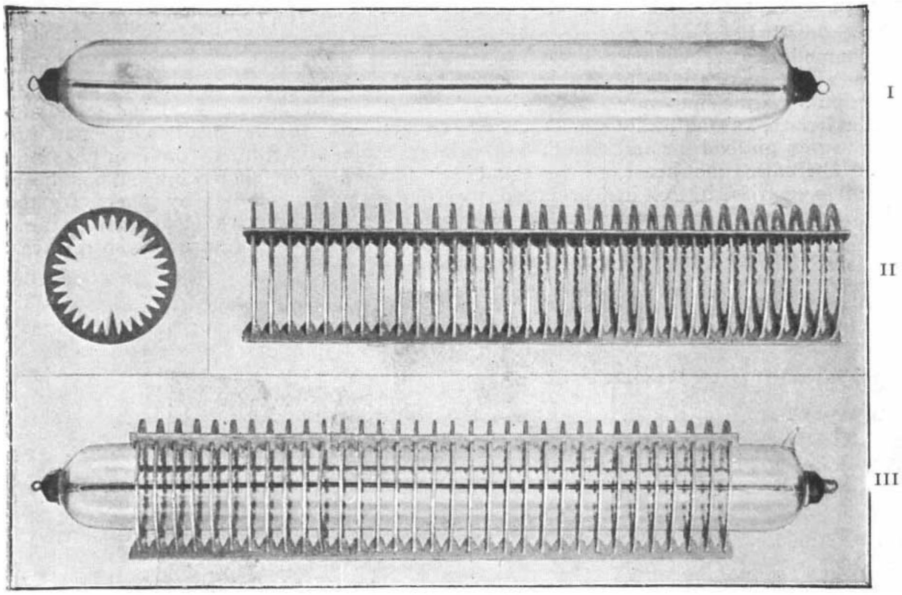

FIG. 2.

For medical purposes the new apparatus takes the form of a vacuum tube (I, Fig. 2), containing a metallic rod. This is surrounded by an armature (II and III, Fig. 2), made of aluminium and armed with points. When the latter and the metallic rod are joined up to a coil or to a step-up transformer a glow makes its appearance, and the air between the two electrodes is rapidly ozonised. If a stream of ozonised air is required for inhalation, or must be conveyed to any particular locality, the above little apparatus is surrounded by a glass jacket, as shown in Fig. 3.

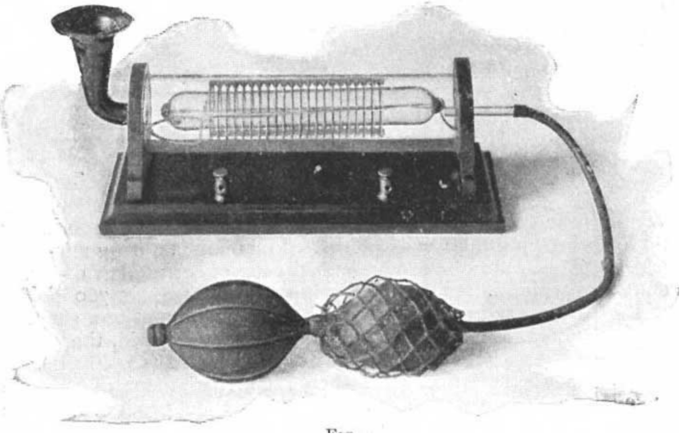

FIG. 3.

Air or oxygen can then be pumped through the apparatus, and thence delivered from a celluloid trumpet for inhalation, or conveyed by a tube to the required locality. The use of india-rubber should be avoided in this part of the apparatus, as india-rubber perishes with astonishing rapidity when exposed to the action of ozone.

It seems often to be supposed by inventors and others, that air and oxygen may be employed indifferently as sources of ozone. This, however, is not really the case. If moderately pure oxygen be used, nitrous fumes are far less likely to be formed than when air is employed; and this is so not only in the event of large sparks passing in the ozoniser, but also when the gas is subjected to the influence of the silent discharge. Unfortunately we do not yet know the exact conditions under which the silent discharge induces the formation of nitric peroxide, though the subject is being investigated; and therefore for the present, unless it can be shown that nitric peroxide is itself beneficial, or, at least, quite unobjectionable, ozone for medical use should certainly be prepared from oxygen whenever it is possible to do so.

A DRAGON OF THE PRIME.

THE little Warwickshire village of Stockton, ploughed and excavated by three manufacturing cement firms, has long yielded to collectors choice specimens of Lower Middle Lias fossils. Its late rector educated the quarrymen by lectures and in conversation to understand and value the vertebræ and belemnites and limas and encrinites which they continually disinterred, forming with their help a collection which on his departure went to form the nucleus of a County Council museum. The Saurian remains have hitherto been always fragmentary, a fact due, perhaps, to the men's careless digging; but the rector left them with a prediction that a perfect monster would some day be unearthed, an entreaty that should they ever come across a head or a continuous backbone, they would drop pick and crowbar, and call in experts to direct and continue the search. A week or two ago the prediction was fulfilled, and the advice remembered. The wielder of a pickaxe suddenly announced that he was "grapplin' along a lot of backbones"; the work was stopped, the foreman summoned, and slowly with due precaution a noble Icthyosaurus was uncovered. He lies 45 feet below the surface; 20 feet in length, the head 2 feet across, and 3 feet 10 inches long. The paddles are unusually distinct, the front pair 2 feet 6 inches, the hind pair 1 foot 8 inches in length. The tail is abruptly curved, and some of the lumbar vertebræ are slightly displaced. The pelvic ring is missing, removed, perhaps, before the nature of the find was guessed, and still to be recovered. The quarry belongs to Mr. M. Lakin, of Leamington, who intends, I understand, to present the specimen to the Natural History Museum at South Kensington. Crowds from all parts of the county throng to see it;